

The Development of 42" 2D/3D Switchable Display

Hoon Kang^{*a}, Mi-Kyoung Jang^{*a}, Kyeong-Jin Kim^{*a}, Byung-Chul Ahn^{*a}, In-Jae Chung^{*a}, Tae-Soo Park^{*b},
Jin-Wook Chang^b, Kyoung-Il Lee^b, and Sung-Tae Kim^{*b}

Abstract

Stereoscopic/autostereoscopic systems have been developed to express 3D images, but have not been successfully use in practise. In order to apply 3D display to promising applications such as advertisements and games, we developed a 42" 2D/3D switchable display. It has characteristics that do not require special glasses for 3D images, uses multi-view technology for improving 3D viewing characteristics, and has a 2D/3D switching function to express dynamic 3D contents as well as conventional 2D contents.

Keywords : 3D display, 2D/3D switching, multi-view, LCD

1. Introduction

Many kinds of researches on 3D display have been done using various aperturing elements such as parallax barriers [1], and lenticular barriers [2]. There have been many trials to put these displays to practical use; however they have been limited to applications such as monitors for professional uses. We have considered other applications for the 3D display and finally focused on the information display. The information display requires accurate information and a large sized screen for many people who want to obtain information. The 2D/3D switching function can give us freedom in using contents and help us deliver information effectively. In this paper, we introduce the characteristics of 3D display so as to use practically and explain main features of the 42" 2D/3D switchable display.

2. Results

2.1 Main characteristics of the 3D display

For the 3D display to be used widely, the following is

required.

1. No use of special glasses.
2. Large screen size, more effective.
3. Multi-view technology for multiple people to see.
4. 2D/3D switchable function.

It must be an autostereoscopic system that dose not need special glasses to see 3D images. It is the first step to use 3D display simply and easily.

Table 1. The comparison of function and performance according to the type of the autostereoscopic 3D systems.

Items	Parallax barrier type	Lenticular type
No use special glasses	○	○
Multi-view tech.	○	○
2D/3D switching function	○	*△
3D luminance	△	○

* It is difficult to make over 40" under the current manufacturing process.

According to the results of evaluation for the 3D image quality by the size of display by using our proto-type (2.83", 19", 42"), the depth reality of the 3D image increase in proportion to the size. The larger size of 3D display not only has positive effect but may also have negative undesirable effects. The moving images possibly cause

motion sickness and more sickness has been observed in conjunction with viewing larger displays [3]. Sharp has demonstrated fully tracked versions of flat panel displays using mechanical tracking technology [4]. The cost of the tracking sensor imposes an obstacle to the consumer application of these displays. So, multi-view technology has to be applied to the 3D display in order to enable numerous people to see the 3D images simultaneously near the best position where the perspective views can be separated properly [5].

Most users would feel visual fatigue if they see 3D images with large depth for a long stretch of time. Proper configuration is required to minimize visual fatigue; displaying conventional 2D images for some time, and subsequently 3D images [6]. Therefore, it should have 2D/3D switching function to express 2D images as well as true 3D images.

2.2 2D/3D switching function

2D/3D switchable display is composed of main LCD, switching LCD, BLU(Back Light Unit) and control part. The Control part is connected to a switching LCD and BLU. When the 3D display is switched from the 2D mode to 3D mode, the control part changes its brightness according to the contents because people can see the images with more comfort. As shown in Fig. 2 in 3D mode, it displays a multiplexed image (stereo image) derived from 15 perspective views on the main LCD, and parallax barrier pattern on the switching LCD. In 2D mode, it displays a conventional 2D image on the main LCD, and transparent or full white on the switching LCD. The control unit reduces the light emitted from the BLU in this mode.

The switching LCD can be positioned in front and behind the main LCD. It is more profitable in terms of image quality (i.e. viewing characteristics of 2D/3D system) to position of the switching LCD to the rear the main LCD.

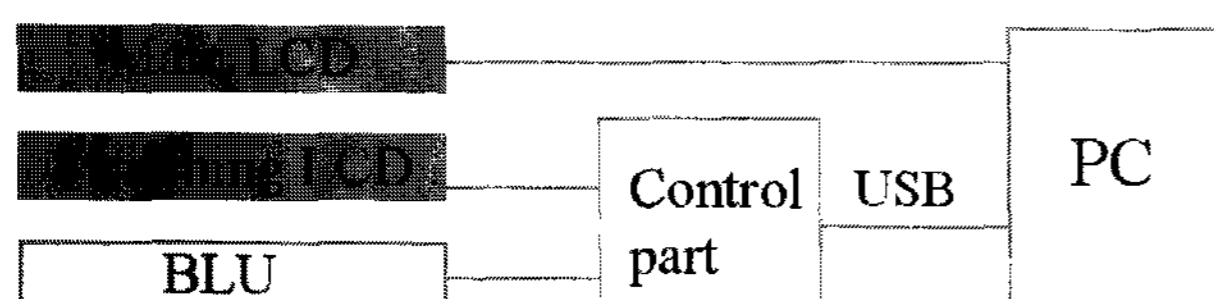


Fig. 1. Schematic diagram for switching 2D and 3D mode

2.3 42" 2D/3D switchable display

We have developed a 42" 2D/3D switchable display as shown in Fig. 2 and it was exhibited at CES 2006 for the first time. It consists of main LCD, 42" S-IPS panel with FHD resolution (1920×1080; LC420WU1), and switching LCD to display parallax barrier pattern.

Table 2, shows the measured characteristics of 42" 2D/3D switchable display. There is no difference of the electro-optical characteristics in 2D mode compared to conventional LCD's. Thus it is possible to utilize various 2D contents. In the 3D mode, the optimum viewing distance from the screen is 4 meters and the luminance

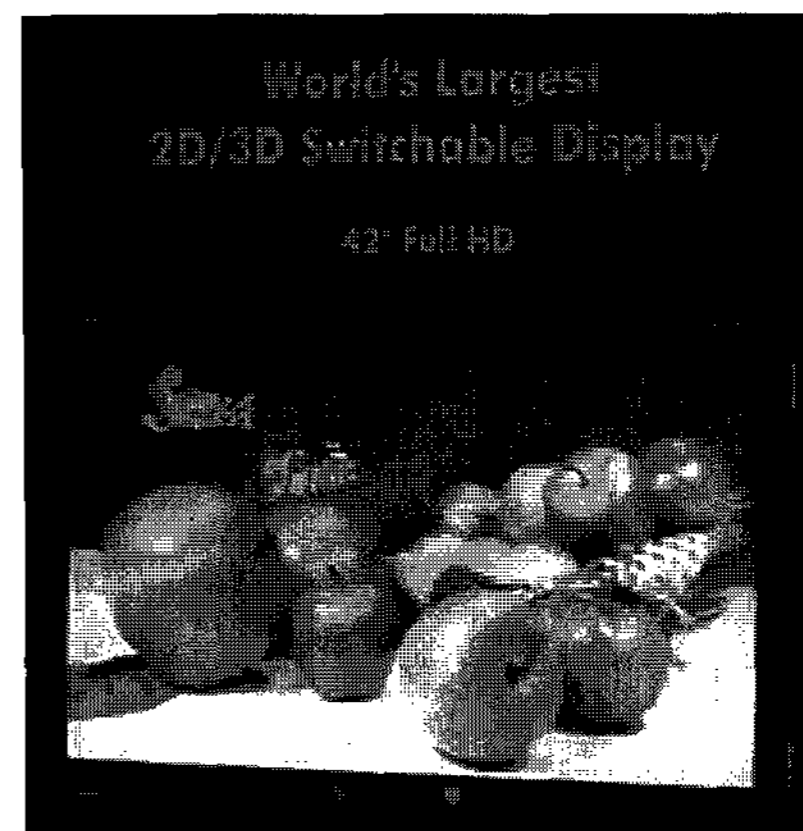


Fig. 2. 42" 2D/3D switchable display which was exhibited at CES 2006.

Table 2. Specifications of 42" 2D/3D switchable display

Items	2D mode	3D mode
1. Size [inch]	42	
2. Resolution	1920×1080	More than SVGA
3. Luminance [nit]	450	200
4. Contrast Ratio	800:1	-
5. Viewing angle[°] (L/R/U/D)	89/89/89/89	-
6. Color gamut [%]	72	-
7. 2D/3D switching	Electrical method	
8. 3D method	Parallax barrier	
9. Multi view technology	-	15 view

10. Optimum position [m]	-	4
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decreases from 450 to 200 [cd/m²]. It needs a high efficient BLU for the producing of 2D/3D switchable display.

The 15 view multiplexing method enables multiple people to enjoy 3D images simultaneously around 3~5 [m] apart from 3D display without lowering of the quality of the 3D image.

In the 2D/3D switching system, we adapted the conventional TN mode because it has simple structure and less process step compare than wide viewing technologies such as IPS and VA mode. However, TN mode has a narrow viewing property in a normal cell design rule.

We have simulated the optimum parameter of switchable LCD for the minimization of the 2D image quality degradation in 42" 2D/3D switchable system. Fig.3 and Table 3 show the white color shifts increase by high retardation value ($d \cdot \Delta n$) of switchable LCD in all viewing directions. In contrast, transmittance of switchable LCD decrease by low retardation value. For the actual application, we decided the retardation value of 320nm for the switchable TN LCD considering the color shifts and transmittance.

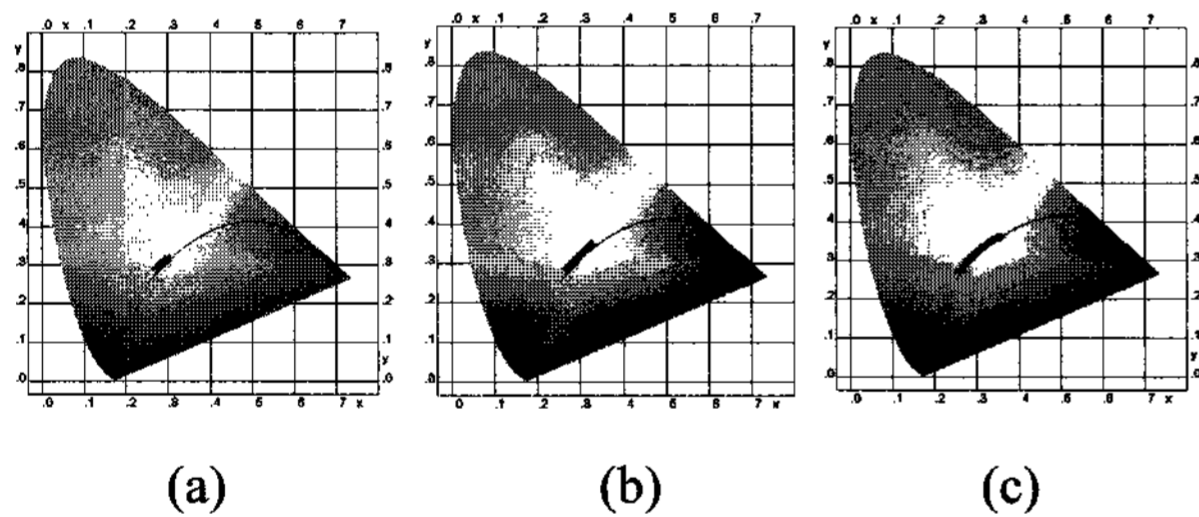


Fig. 3. The color shifts of switchable LCD base on the simulation conditions as a following $d \cdot \Delta n$, (a) 220nm (b) 320nm and (c) 440nm.

Table 3. The simulation results of switchable LCD depend on the three different retardation

Simulation Cond.	a	b	c
$d \cdot \Delta n$ [nm]	200	320	440
Trans[%]	18.25	32.64	42.52
$\Delta u'v'$ (@ white)	0.021	0.044	0.056

Based on the simulation results, we prepared the proto sample of 42" 2D/3D switchable system combined the TN switchable LCD and S-IPS main LCD. We did not see any difference in the electro-optical characteristics in 2D mode

as a shown in Fig. 4.

Fig. 5 shows viewing angle for 3D images to be seen comfortably without image flipping in the 3D mode. In other words, users can see 3D images comfortably in the range of 40 [cm] horizontal.

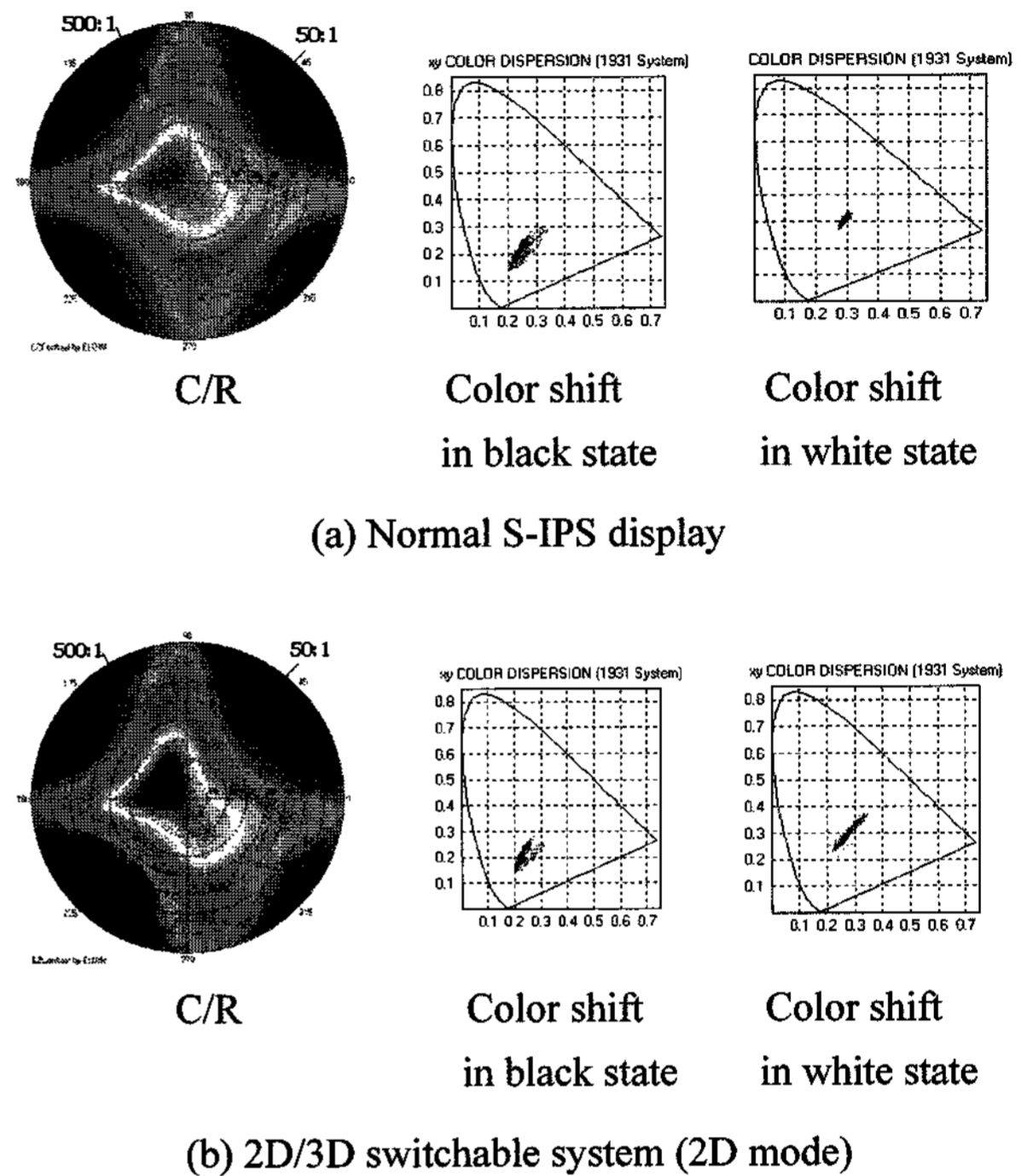


Fig. 4. Electro-optical characteristics such as contrast ratio and color shift with respect to the all directions in the 2D mode compared to conventional LCD, i. e. (a) normal S-IPS (b) 2D/3D switchable system(2D mode).

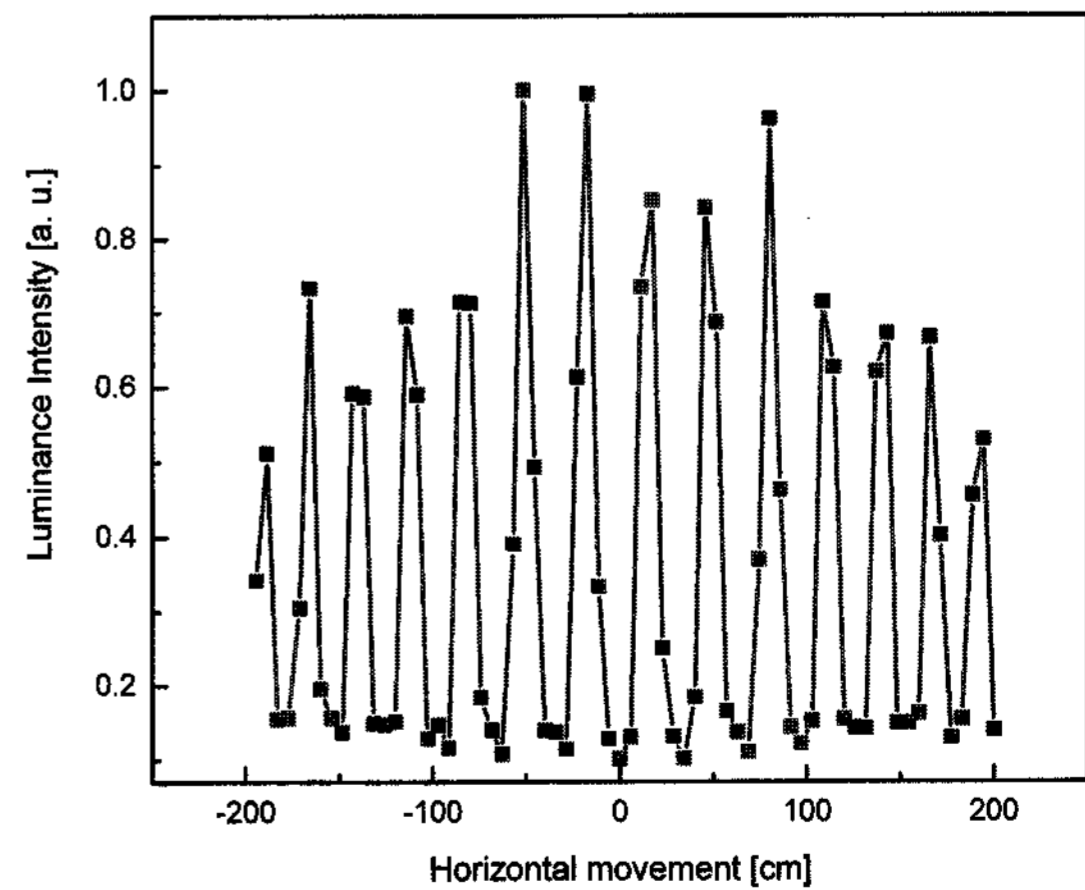


Fig. 5. Viewing characteristics in the 3D mode. Luminance intensity with respect to horizontal movement is measured at the

optimum position.

3. Conclusion

We developed the 42" autostereoscopic system that has 2D/3D switching function. It will be applied to an information display, a booming display field as well as games and simulations. The large sized 2D/3D switchable display will be a new premium product which can display dynamic 3D images as well as high quality 2D images.

References

- [1] Mashitani, K., *Proc. of Asian Symposium on Information Display(ASID '98)*, p. 151.
- [2] S.T. de Zwart, W.L. IJzerman, T. Dekker and W.A.M. Wolter, *Proc. of the International Display Workshop (IDW '04)*, p. 1459.
- [3] H. Ujike, T. Yokoi and S. Saida, *Proc. of the International Display Workshop(IDW '05)*, p. 1727.
- [4] G. Woodgate, R. Moseley and D. Ezra, *European Patent*, EP0829743(1996).
- [5] T. Dekker, S.T. de Zwart and W.L. Ijzerman, *Proc. of International Meeting on Information Display(IMID '05)*, p. 31.
- [6] Sumio Yano, Shinji Idea, Tetsuo Mitsuhashi and Hal Thwaites, *Displays*, **23**, 191(2002).